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APPLICATION FOR LETTERS PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

TITLE: **Bariatric Bed Apparatus and Methods**

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EXPRESS ... EH102820010US
Date of Deposit 31 Jan 19 95
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BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION.

The present invention relates to bariatric beds and, more particularly, to bariatric beds of the type convertible to a reclining bariatric chair and having features for facilitating the comfort, care and support of the bariatric patient.

2. BACKGROUND.

The care of morbidly obese patients, also known as bariatric patients, presents many extraordinary challenges which have not been adequately addressed in the past. Not the least of the challenges is basic physical handling of such patients. Even partially lifting a bariatric patient often requires three or four very strong nurses. Supporting their huge size and weight on a bed likewise requires the bed to have tremendous structural strength and stability. An eight hundred pound patient will not only render many of the controls of a typical hospital bed inoperative, but will literally crush components just by sitting on the bed. Structural instability, moreover, tends to increase with complexity. Consequently, although standard hospital bed frames like the Hill-Rom 835 frame can be full-featured, caregivers of bariatric patients have long had to rely on bariatric beds with very basic support structures and limited features.

Examples of known bariatric beds include the "Magnum" bed previously manufactured by Mediscus Products, Ltd. of Wareham, England and the "Burke" bed manufactured by Burke, Inc. of Mission, Kansas.

SUMMARY OF THE INVENTION

It is a fundamental object of the present inventions to improve over the prior art, including to provide a bariatric bed and related methods which facilitate the care, comfort and support of bariatric patients. A related object is to provide a bariatric bed with features comparable to those of a conventional hospital bed while also providing features uniquely adapted for the care, comfort and support of bariatric patients.

These and other objects are addressed, in part, by providing a full-featured bariatric bed. One basic aspect of the invention is to provide such a full-featured bariatric bed wherein the frame includes a raise-and-lower mechanism together with controls for tilting the patient surface lengthwise, hence providing Trendelenburg and/or reverse Trendelenburg capabilities. Structure is also provided for articulating the patient surface from a relatively horizontal, lying position to a seated position. The raise-and-lower mechanism may include two separately actuated jacks of sturdy placement and construction, one for lifting the foot end of the bed's seat section and the other for lifting the head end of the bed's seat section. Such construction permits general raising or lowering of the entire patient surface by operating the jack motors synchronously in the same direction, and permits longitudinal tilting by operating the jack motors at different speeds or in opposite directions.

Another aspect of the present invention is the provision of opposite siderails that are both adjustable and retractable. The siderails are adjustable in the sense that they can be raised and locked in their operative position at a lateral distance (i.e., distance from the primary seat cushion) that is adjustable. They can be raised in a normal, inner position, or they can be adjusted to an extended position for particularly wide patients. They can even be adjusted further inward than their normal position without being removed from the bed, to a transport position for facilitating transport of the bed through standard hospital doorways. The siderails are retractable not only in the sense that they can be retracted to the transport position, but also in the sense that the can be easily

lowered without removing them from the bed. To further enhace the user-friendliness of the bed, the invention also provides for the provision of identical bed controls built in to each of the opposite siderails. Thus all functions can be controlled from a convenient control panel. Such controls are integrated into the siderails without risking injury to the siderail data lines by directing those lines through a tunnel in the siderail mounting arms. Pendant controls may also be included for even greater ease of use.

Yet another aspect of the present invention is the provision of a bariatric bed including a balanced X-ray cassete holder for enabling use of a radioluscent head section thereof. The entire central span of the head (and chest) section may be radioluscent, and the balanced X-ray cassette holder allows adjustment of X-ray film position thereunder.

The present invention also provides a bariatric bed having a footboard which is adapted for use as a step to enable ingress and egress relative the bed. Such a footboard may be pivotally connected to the leg section of the bariatric bed so that it can pivot into close engagement with the floor when stepped on. Damping cylinders and springs may be used to optimally restrict such pivoting in use, and upper and lower cushions, ideally of different properties, may be employed for further benefits.

Although some details are summarized above, this summary generally only begins to touch on the broader technological categories to which the present inventions are directed. Many other objects, features and advantages of the present inventions will be evident to those of skill in the art in view of the foregoing and following more detailed descriptions, particularly when considered in light of the prior art and/or the claims appended hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a bariatric patient treatment bed **29** comprising the presently preferred embodiment of the invention described herein.

FIG. **2** is an exploded perspective view of the bariatric patient treatment bed **29** of FIG.**1**.

FIG. **3** is an exploded perspective view of the base frame **61** and plastic base frame covers **46-48** and **250** for the bed **29** of FIG. **1** shown with some parts removed for clarity.

FIG. **4** is an exploded perspective view of the base frame **61**, load frame **62** and scale mechanism of the bed of FIG. **1** shown with some parts removed for clarity.

FIG. **4**A is an enlarged scale sectional view showing the flexure elements of the scale mechanism which dependently attach the load frame **62** to the base frame **61**.

FIG. **5** is an exploded perspective view the load frame of the bed of FIG. **1**.

FIG. **6** is an exploded perspective view of the seat assembly of the bed of FIG. **1**.

FIG. **7** is an exploded perspective view of the head and X-ray assembly of the bed of FIG. **1**.

FIG. **8** is an exploded perspective view of the left hand side rail assembly of the bed of FIG. **1**.

FIG. **9** is an exploded perspective view of the leg and foot assemblies of the bed of FIG. **1**.

FIG. **10** is an exploded perspective view of the hand held control pendant for the bed shown in FIG. **1**.

FIG. **11** is a schematic view of the power distribution and control system for the bed of FIG. **1**.

FIG. **12** is a flow chart showing serial communication for the control system of FIG. **11**.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIGS. **1** and **2**, there is shown a treatment bed **29** uniquely indicated for bariatric patients, i.e, patients weighing in excess of 500 pounds, commonly in the range of 500-800 pounds. The bed **29** shown is considered to be the presently preferred embodiment of the inventions described and claimed herein. The frame **10** of bed **29** (with particular reference to FIG. **2**) generally comprises base frame **61**, load frame **62** and assemblies **51**, **52**, **53** and **54**. The basic mattress **11** (or "patient surfaces), of bed **29** consists of Cushion assemblies **31**-**33** 30, although overlay surfaces may also be implemented on top of the basic mattress **11** controls for the bed **29** are contained in the frame **10**, including in its side rails **40-41** and it's pendant. Frame assemblies **51-54** and corresponding cushion assemblies provide support for the patient's head, buttocks, legs and feet, respectively. Head and X-ray assembly **51** (also referred to as "X-ray assembly **51**") further comprises a mechanism for holding an X-ray cassette as shown by FIG. **7** and detailed further herein. Seat assembly **52** further comprises jack motors **114** and **116** as shown in FIG. **6**. Jack motors **114** and **116** are used to adjust the angular orientation relative to seat assembly **52** of head and X-ray assembly **51** and leg assembly **53**, respectively, as will be evident further herein. Foot board assembly **54** is dependently attached to leg assembly **53** by connections providing useful benefit to both the patient and care giver as shown in FIG. **9** and detailed further herein. Cushion assemblies **30**, **31**, **32** and **33** rest upon head assembly **51**, seat assembly **52**, leg assembly **53**, ~~and~~ foot board assembly **54**, respectively. Cushion assemblies **30-33** engage the patient to provide comfortable support thereof.

As best shown in FIG. **3**, base frame **61** generally comprises longitudinal beams **65** and **66** and transverse elements **63** and **64**. Base frame **61** further comprises a plurality of floor engaging casters **34**, **35**, **36**, and **248** conventionally journaled near the four corners of said frame. Locking mechanisms **37**, **38** and **39** and a fourth of the same kind (not shown) are provided for casters **34**,

35, **36**, and **248**, respectively. Such locking mechanisms may be set to prevent either rotation or steering of the casters **34-36** and **248**, hence holding bed **29** stationary, as is conventional with many hospital bed frames. Weldments **68-71** are provided which allow location of corner posts **42-44** and **249** on which may be installed intravenous injection (IV) holders or standard traction frames. Corner posts **42-44** and **249** are adapted with convenient integral hand holds **42'-44'** and **249'** to facilitate patient entrance or exit of bed **29**. The hand holds **42'-44'** and **249'** provided by corner posts **42-44**, and **249** may also assist caregivers in transport of bed **29**. Molded plastic covers **46-48** and **250** enhance aesthetic appeal and provide convenient locations for affixing instruction or warning labels. Bumpers made of rubber or other similar materials may also be installed on covers **47** and **48** for protection of both bed **29** and the walls and doorways of the facility where the bed is used.

As best shown in FIG. **4**, load frame **62** generally comprises longitudinally disposed beams **72** and **73** and transverse elements **74** and **75**. Additional transverse elements **76** and **77** are used for attachment of jack motors **90** and **92**, respectively. The description and function of motors **90** and **92** will be apparent further herein. Load frame **62** is referred to as such because it carries the entire load of the patient surface **11**. Load frame **62** dependently attaches to base frame **61** in a way that weighs that load as it is transmitted to base frame **61**. That connection between bed frame **62** and base frame **61** is provided by a scale mechanism is well known in the art and similar to that described in U.S. Pat. No. 4,793,428, incorporated herein by this reference. The scale mechanism comprises a pair of displacement transmitting members **84** and **85** which are respectively connected between transverse elements **63** and **74** and **64** and **75** via flexures **78-81** and **243-246**.

Referring to detail FIG. 4A, transmitting member **84** is shown as attached to base frame element **63** via flexure **246** and load frame element **74** via flexure **81**. Attachment in this manner causes displacement of bars **82** and **83** which are connected to members **84** and **85** in cantilevered manner. Displacement, which is limited by springs **86** and **87**, is measured in the area

of springs **86** and **87** by linear variable differential transformers (LVDTs) **88** and **89**. Displacement measured by LVDTs **88** and **89** corresponds in direct proportion to the weight of the load frame and all which is supported thereby. Locking mechanism **67** comprising common hardware is desired to prevent motion of load frame **62** relative to base frame **61** during transport of bed **29**. This serves to prevent damage of the scale mechanism due to excessive forces as may be encountered when attempting to negotiate a short step or the like. Other conventional mechanical stops are also used to limit movement and prevent damage in normal use, when locking mechanism **67** is not in use.

Referring to FIGS. **5** and **6**, raise-and-lower mechanism for producing vertical movement Trendelenburg tilting of the seat assembly **52** is shown in detail. In particular, head torque arm weldment **106** and foot torque arm weldment **110** are pivotally attached to load frame **62**. Seat assembly **52** is dependently attached to weldments **106** and **110** by members **102, 105, 108** and **109**. Specifically, foot torque arm weldment **110** connects at points **101** and **107** to members **108** and **109** by bushings and other necessary hardware as is well known in the art of manufacturing hospital beds. Head torque arm **106** and foot torque arm **110** weldments are articulated about their pivotal attachments to load frame **62** (numbered **106'**, **106''** and **110'**, **110'**, respectively)by extension or retraction of jack tubes (or "sleeves") **91** and **93** by jack motors **90** and **92**, respectively. Jack motors **90** and **92**, of the type referred to in the industry as linear actuators, attach transverse members **76** and 77 of load frame **62** by torque arm pins **95** and **97** themselves affixed by cotter pins **96** and **98**.

Extension of tube **93** by motor **92** causes weldment **110** to pivot relative to load frame **62** such that points **101**, **107** and corresponding members **108**, **109** articulate upwardly. Likewise, extension of tube **91** by motor **90** causes weldment **106** to pivot such that members **102** and **105** articulate upwardly. Retraction of tubes **93** or **91** would have the opposite effect, that of lowering members **108, 109**, or **102, 105**. Said articulation has the effect of causing members **102, 105, 108**

and **109** to raise or lower in vertical motion, thereby raising or lowering seat assembly **52** in vertical motion. In the preferred embodiment, such articulation as raises seat assembly **52** is said to provide a BED UP function. Such articulation as lowers seat assembly **52** is said to provide a BED DOWN function. It is believed that the system described herein having mechanically articulated attachment points at the four corners of seat assembly **52** promotes greater stability than would a system utilizing hydraulic type cylinders wherein the support is typically concentrated along a single longitudinal axis.

Articulation by one jack motor **90** or **92** greater or less than that of the other jack motor **92** or **90** has the effect of establishing the patient support surface in a Trendelenburg or reverse Trendelenburg treatment position. Trendelenburg and reverse Trendelenburg therapy is well know in the art for treatment of certain cardiac conditions and is considered an important feature for many conventional hospital beds, although the excessive weight of bariatric patients has led the art away from incorporating such features in a bariatric bed. The preferred embodiment is capable of achieving ten degrees Trendelenburg or twelve and one half degrees reverse Trendelenburg therapy. Articulation to effect such treatment is referred to as providing the TRENDELENBURG or REVERSE TRENDELENBURG function.

Referring now to FIG. **5** only, load frame **62** is shown to be a convenient location for mounting of transformer assembly **103** and junction box assembly **104**. The functions of each of these assemblies will be detailed further herein. Additionally, inductor-capacitor-resitor (LRC) networks **99** and **100** are conveniently mounted on load frame **62** so as to conserve space within junction box assembly **104**. LRC networks assemblies **99** and **100** are primarily indicated for the capacitive startup of jack motors **90** and **92** and protection of the power distribution and control system from back electromotive forces (EMF) generated by said initial startup of either jack motor **90** or **92**.

Referring to FIGS. **6** and **7**, it is shown that head assembly **51** is dependently attached to seat assembly **52** by laterally oriented hinge **131**. Articulation of head and X-ray assembly **51** about hinge **131** is effected by extension or retraction of jack sleeve **117** under the force of jack motor **116**. Jack motor **116**, of the type referred to in the industry as a linear actuator, dependently attaches to seat assembly weldment **112** by pin **120**, itself affixed by cotter pin **121**. Jack sleeve **117** attaches to head and X-ray assembly weldment **132** by pin **118**, itself affixed by cotter pin **119**. In the preferred embodiment, extension of jack sleeve **117** is said to provide a HEAD UP function. Retraction of jack sleeve **117** is said to provide a HEAD DOWN function. Head and X-ray assembly **51** is detailed further herein.

Referring now to FIG. 7, the head assembly **51** for treatment bed **29** is shown. Head assembly **51** generally comprises rail **140** encompassing head board **141** which together are mated with weldments **128**, **129** and **130**. Weldments **128** and **129** produce a channel for horizontal containment of an X-ray cassette. Transverse weldment **130** combines with hinge **131** and weldment **132** to provide structural support of head and X-ray assembly **51**. X-ray board **139** serves to maintain the right angled shape of the perimetrical structure thereby aiding in ensuring ease of insertion and removal of an X-ray cassette. X-ray board **139** and head board **141** comprise a radioluscent material in the preferred embodiment. While it is well known in the art of design and manufacture of patient treatment beds to provide a mechanism for holding an X-ray cassette behind the patients head and chest areas, prior art designs have not improved the means for insertion and removal of the X-ray cassette. Specifically it is desirable to be able to raise or lower the cassette from one side only so that in cases where access to the treatment bed may be limited to one side, by a wall or medical apparatus, for instance, an X-ray cassette still may be easily inserted and subsequently removed. Because prior art embodiments of bariatric beds do not provide mechanisms for keeping the sides of an X-ray cassette parallel with the sides of holding assembly, the caregiver

has been forced to have access to both sides of the treatment bed in order to manually guide the cassette into place. The embodiment detailed herein utilizes a mechanism from other arts to provide a solution to the problem described. A block and pulley system comprising a left block and right block **134**, plurality of single pulleys **136** and **138**, plurality of double pulleys **137** and plurality of cables **135** allows X-ray bar **133** to be raised and lowered from one only of a plurality of handles **142** all the while maintaining position parallel to transverse element **130**. The handles **142** may lock at a plurality of vertical positions within slots **143** in channel members **128** and **129**. Although referring to an un-related field of art, the block and pulley system shown is similar to that described in U.S. Pat. No. 5,295,430, incorporated herein by this reference.

Referring now to FIGS. **6** and **9**, it is shown that leg assembly **53** is dependently attached to seat assembly **52** by laterally oriented hinge **113**. Articulation of leg assembly **53** about hinge **113** is effected by extension or retraction of jack sleeve **115** under the force of jack motor **114**. Jack motor **114**, of the type referred to in the industry as a linear actuator, dependently attaches to seat assembly weldment **112** by pin **122**, itself affixed by cotter pin **123**. Jack sleeve **115** attaches to leg assembly weldment **194** by pin **124**, itself affixed by cotter pin **125**. In the preferred embodiment, extension of jack sleeve **115** is said to provide a LEGS UP function. Retraction of jack sleeve **115** is said to provide a LEGS DOWN function. Leg assembly **53** is detailed with foot board assembly **54** further herein.

In the preferred embodiment, full extension of jack sleeve **117** in order to provide full HEAD UP and simultaneous full retraction of jack sleeve **115** in order to provide full LEGS DOWN causes conversion of patient treatment bed **29** into a reclining chair. In combination with unique benefits provided by the leg and foot board assemblies **53** and **54**, detailed further herein, the chair position of treatment bed **29** particularly facilitates entrance or exit of the bed by a bariatric patient. It should also be noted that seat assembly **52** provides convenient mounting for patient restraint system

weldments **126** and **127**.

Referring to FIG. **9**, there is best shown foot board assembly **54** as dependently attached to leg assembly **53**, also shown. Leg assembly **53** generally comprises leg plate **161** as reinforced by "I" shaped weldment **194**. Weldment **194** itself comprises a plurality of attachment points **169**, **176** and **183**, the purpose of which will be evident herein. Foot board assembly **54** generally comprises foot plate **162**, a plurality of hinges **186** and **189**, cushions **163** and **164** and heavy duty fabric cover **33**. The cover **33** in the preferred embodiment, is "Dartex" P109" available from Penn-Nyla of Nottingham, England, as is the fabric covering for the whole of mattress **11**.

As for the foam used in mattress **11**, a wide variety may be suitable; however, with the exception of cushions **163** and **164**, the foam used in the preferred embodiment is an antimicrobial open-cell polyurethane foam having a density of 1.8 pounds per cubic foot and 36 pounds compression. The foam used for cushion **163** in the preferred embodiment is similar but has a relatively large density of 2.7 pounds per cubic foot and 70 pounds compression. The foam used for cushion **164** in the preferred embodiment is also similar but is less dense than cushion **163**, having a density of 2.0 pounds per cubic foot and 41 pounds compression. Both cushions **163** and **164** are wedge-shaped, with their greater thicknesses (roughly 1.75" and 0.5", respectively) being distal to hinge **189**. The relative characteristics of these foam cushions serve their varied purposes.

It is well know in the art of design and manufacture of bariatric patient treatment beds to provide a means by which the patient can easily enter or exit the bed. Bariatric patients are often not able to hop or step down even short distances without injury or loss of balance. It is therefore to provide a means for entrance or exit which lifts the patient into the bed and similarly sets the patient's feet very near the floor when exiting the bed. In the prior art, it has been shown that a rigid foot board in combination with a chair position feature, as previously detailed herein, facilitates bariatric patient care. However, measures are taken to ensure such foot boards are not used as a step

when exiting the bed, presumably for safety reasons in view of the excessive weight of bariatric patients. The present invention goes against such teachings by providing a footboard **54** which is adapted to be used safely as a step for bariatric patients.

Referring still to FIG. **9**, the attachment of foot board assembly **54** to leg assembly **53** is shown. Such attachment provides gradual increase in rigidity as weight is applied to foot cushion **35**, so as to provide adequate support of the bariatric patient entering or exiting bed **29** yet avoiding fixed resistance to a sudden increase in force. It is shown that the primary attachment of foot board assembly **54** to leg assembly **53** is by hinge **186** through weldments **187** and **188** on the foot board assembly **53** and a plurality of holes **197** in weldment **194** of the leg assembly **53**. Articulation about said hinge **186** is constrained by damping cylinders **172** and **179** and spring **165** as detailed further herein. Spring **165**, in compression, attaches to leg assembly weldment **169** by pin **170** itself affixed by cotter pin **171**. Spring **165** attaches to foot board assembly weldment **166** by pin **167**, itself affixed by cotter pin **168**. Hydraulic cylinder **179**, of the type which dampens primarily in compression, attaches to leg assembly weldment **183** by pin **184** itself affixed by cotter pin **185**. Hydraulic cylinder **179** attaches to foot board assembly weldment **180** by pin **181**, itself affixed by cotter pin **182**. Hydraulic cylinder **172**, of the type which dampens primarily in tension, attaches to leg assembly weldment **176** by pin **177** itself affixed by cotter pin **178**. Hydraulic cylinder **172** attaches to foot board assembly weldment **173** by pin **174**, itself affixed by cotter pin **175**. The particular cylinder **179** selected in the preferred embodiment is an adjustable cylinder having a two-inch stroke and available through Enidine of Orchard Park, New York, part number (LR)OEM 1.5M X 2. The particular cylinder **172** selected in the preferred embodiment is an adjustable cylinder having a four-inch stroke and available through Enidine of Orchard Park, New York, part number ADA 510T. The particular spring **165** selected in the preferred embodiment is a medium load round wire spring available through Lee Spring Company of Brooklyn, New York, part number LHL-1

500A-9MW.

Under the weight of a bariatric patient, hydraulic cylinder **179** increasingly resists articulation of foot board assembly **54** about hinge **186**. Gradually, resistance will increase as more weight is applied by the patient. In this manner, foot board assembly **54** is able to provide increasingly rigid support of the bariatric patient while minimizing any risk of **54** snapping under the weight of a typical bariatric patient. Further if a bariatric patient should apply weight onto foot board **54** at excessive speed, the dampening action of hydraulic cylinder **179** may serve to prevent injury to the patients knees and legs. One weight is removed from foot board **54** (such as once patient has completely exited bed **29**), spring **165** returns foot board assembly **54** to its original position with respect to leg assembly **53**. Hydraulic cylinder **172** in tension dampens the return motion of spring **165**. This damping helps prevent snapback of the foot board assembly **54**, which might otherwise present safety hazards.

The cushion **33** not only enhances patient comfort but can also cushion engagement of foot board **54** with the floor, as the patient exits or enters bed **29**. Additionally, in case a care giver is unalert and places a foot beneath foot board assembly **54**, and a patients weight does cause foot board assembly **54** to contact the caregiver's foot, heavy padding of cushion **163** distributes the weight and cushions the foot to help prevent excessive discomfort to the caregiver.

Pins **190** and **191** held in position beneath foot board assembly **54** by nuts **192** and **193** may be placed in a release position so as to allow foot plate **162** to articulate about secondary attachment hinge **189**. Said release allows patient support foot cushion **33** to lie coplanar with leg cushion **32**. This may be desirable when the bed surface is in a horizontal position if the caregiver wishes to minimize pressure against the patients feet.

As is best shown by FIG. **8**, the left side rail generally comprises metal frame **144** encased by molded plastic covers **145** and **146**. Frame **144** is generally dependently attached to side rail

mounting plate **149** through weldments **59** and **60** and shafts **147** and **148**. Weldments **59** and **60** and shafts **147** and **148** are themselves major components of a mechanism **56** for raising and lowering of side rail assembly **41**. Said mechanism **56** is also utilized for lateral translation of side rail assembly **41** thereby extending or compressing the lateral dimension of treatment bed **29**. Details of the manufacture and use of mechanism **56** will be evident further herein.

Referring still to FIG. **8**, molded plastic covers **145** and **146** serve not only to provide aesthetically pleasing appearance, but provide mounting for a side rail micro-controller unit **156**, scale function membrane switch **157**, and bed function membrane switch **158**. Additionally, covers **145** and **146** provide mounting for a liquid crystal display (LCD) **160** and receptacle **159** used to provide optionally connectivity for a hand held bed function control pendant **45**. Pendant **45** is shown in FIG. **10** and detailed further herein.

Scale function membrane switch **157** allows a caregiver to effect scale operations such as ZERO, HOLD, WEIGH DELAY, SET and EXIT ALARM. Liquid crystal display **160** is necessary for visual feedback to the care giver in effecting scale operations as such effect takes place through a system of menus. The details of all scale operations will be evident further herein. Bed function membrane switch **158** allows a caregiver to effect operations of BED UP, BED DOWN, HEAD UP, HEAD DOWN, LEGS UP, LEGS DOWN, TRENDELENBURG and REVERSE TRENDELENBURG as previously described. Side rail micro-controller unit **156** processes input from scale function membrane switch **157** and bed function membrane switch **158** and generates display information for LCD **160**. Data communication from the switches **157** and **158** and the other control components in siderail **144** are conveyed to the master controller via line **60'**, which passes through a central tunnel in member **60** and shaft **148**. As will be evident further herein, micro-controller unit **156** serves as a slave in the serial communications architecture of the preferred embodiment. This architecture is shown in FIG. **12**.

The scale function ZERO allows the weight of the bed to be set to zero prior to patient placement thereby compensating for linens and accessories. Scale function HOLD retains the current weight in memory while additional items, such as traction equipment, are added thereby eliminating inaccuracies as would otherwise be introduced by such activity. The scale function WEIGH DELAY postpones weighing for a specified time while tubes, drainage bags and the like are lifted thereby giving accurate reflection of the patient's weight only. Scale function SET is used to enter a previously known weight of the patient. Scale function EXIT ALARM detects weight decreases of ten percent or more and in such case sounds an audible alarm.

Referring back to FIG. **2**, wherein both left side rail **41** and right side rail **40** are depicted, dependent attachment of left side rail **41** is shown to comprise not only mounting plate **149**, weldments **59** and **60** and shafts **147** and **148**, but also mechanism **56**. As is apparent by depiction of weldments **57** and **58** and mechanism **55** for right side rail **40**, all components and functions of left side rail **41** are mirrored in right side rail **40**. Referring again to FIG. **8**, mechanism **56** comprises those elements necessary for raising, lowering or laterally translating left side rail **41**. Weldments **59** and **60** are dependently cantilevered from shafts **147** and **148** in fixed position. Shafts **147** and **148** freely rotate and slide laterally within bushings **149** and **150**. Bushings **149** and **150** are dependently attached to mounting plate **149** in fixed position. Pawls **152** and **153** are connected by rod **154** in such manner as to require coordinated motion of said pawls. A plurality of rectangular pegs form teeth on shafts **147** and **148** in such a manner as to form a ratchet mechanism with pawls **152** and **153**. In the preferred embodiment, the said ratchet mechanism allows side rail **41** to be raised by lifting only from a lowest TRANSPORT position to either a middle LOWERED position or the upper RAISED position. In order to lower side rail **41** from the RAISED position to the LOWERED position or from the LOWERED position to the TRANSPORT position, lever **155** must be manually articulated in order to cause release of pawls **152** and **153** from the teeth of shafts **147**

and **148**. From the LOWERED position, side rail **41** may be freely translated laterally outward from the center of bed **29**. This configuration is referred to as EXTENDED in the preferred embodiment. From the EXTENDED position, side rail **41** may be returned to the RAISED position. Side rail **41** which is in EXTENDED RAISED position must be lowered prior to translation back toward the center of bed **29**, the NORMAL position. In the TRANSPORT position, side rail **41** of the preferred embodiment may be further translated toward the center of bed **29** beneath seat assembly **52** thereby reducing the overall lateral dimension of bed **29** sufficiently so as to be able to fit said bed through a standard hospital doorway. Although the excessive width of bariatric patient treatment beds has long been recognized as an undesirable characteristic for transport, prior art embodiments of bariatric patient treatment beds have failed to provide an economical, reliable and easy-to-manufacture side rail design with multiple functions and *abilities* for use on a bariatric bed such as bed **29**.

As is well known in the art of design and manufacture of treatment beds for bariatric patients, the bariatric patient is often of such limited mobility as to make it impracticable for said patient to utilize bed function controls mounted on a side rail. Referring now to FIG. 10, there is best shown a hand held bed function control pendant **45**. Pendant **45** comprises molded plastic body **198** encompassing necessary electronic hardware as is common in the industry and clip **201** held by gasket **202**. Clip **201** allows the patient to attach pendant **45** to clothing or other articles increasing accessibility to pendant **45**. Pendant **45** includes a plurality of push button switches **203-210** allowing the patient to control such functions as BED UP, BED DOWN, HEAD UP, HEAD DOWN, LEGS UP and LEGS DOWN as have been previously detailed. Pendant **45** attaches to either the left or right side rail **40** or **41** by cord **199** and plug **200**. As will be apparent further herein, the serial communications architecture of bed **29** is interrupt driven. This architecture allows pendant **45** to be inserted in parallel with side rail controls **158** without need for further configuration.

Referring to FIG. 11, the power distribution and control structure for the preferred

embodiment is shown. Each side rail **40** and **41** comprises a "Intel" 8031 type micro-controller **156** and **215**, a plurality of membrane switches **156**, **158**, **212** and **214**, LCDs **160** and **216** and pendants **45** and **213**. Additionally each side rail **40** and **41** comprises attachment points **211** and **217** for parallel electrical connection of pendants **45** and **213** with membrane switches **158** and **212**. Within the junction box assembly **104** of bed **29** there is a "Intel" 8031 type micro-controller scale interface unit **222**, a "Intel" 8031 type micro-controller solid state relay master micro-controller **220** and power interface unit **221** which serves to carry out bed function control inputs. The "Intel" 8031 type micro-controller of the solid state relay integrated circuit board **220** operates as a serial communication master controller. Board **220** communicates to slave controllers, namely to each of the "Intel" 8031 type micro-controllers **156** and **215** embedded within each side rail **40** and **41**, as well as a third "Intel" 8031 type micro-controller on the scale interface unit integrated circuit board **222**. The transformer assembly **103** comprises transformer **247** and main power switch **219** as well as standard power cord **218**. Optional limit switches **223** may be placed on the bed as desired for safety purposes and interfaced to solid state relay board **220**.

As is best shown by the flow diagram of FIG. **12**, subsequent to the completion of the power-on initialization sequence of bed **29** for each of its electronic assemblies, the solid state relay board micro-controller initiates **225** a one hundred millisecond serial communications sequence **224** in a 25 millisecond timed interrupt driven process. Once every 25 ms the solid state relay board micro-controller communicates with one of its three slaves. The serial communications sequence **224** operates as a continuous loop and at the conclusion **242** of each 100 ms cycle the sequence starts again at step **225**.

During the first 25 ms stage designated as step **226** of the serial communication sequence **224** data denoting left side articulation commands, left side alarm weight, left side zero weight, left side activation status, and left side exit alarm activation status is read from the RAM of the left side

micro-controller unit **156** and written to the RAM of the solid state relay board **220**. During the second 25 ms interrupt stage designated as step **227** of the serial communications sequence **224**, data denoting right side bed articulation commands, right side alarm weight, right side zero weight, right side activation status, and right side exit alarm activation status is read from the RAM of the right side micro-controller unit **215** and written to the RAM of the solid state relay board **220**. In step **228**, at the beginning of the third 25 ms interrupt stage of serial communication sequence **224** the solid state relay board micro-controller unit **220** determines if the right side micro-controller unit **215** has been activated for scale functions during the present 100 ms cycle, one cycle being defined as consisting of those elements shown in FIG. **12**. If in step **228** it is found that the right side micro-controller unit **215** has been activated for scale functions within the present cycle, the remaining time in the third 25 ms interrupt stage is utilized by step **229** of serial communications sequence **224** to replace display of scale information on the left side rail LCD **160** with a message stating that the left side is inactive for scale functions. If in step **228** of serial communications sequence **224** it is determined that the right side micro-controller unit **215** has not been activated for scale functions within the present cycle, the solid state relay board micro-controller unit **220** then determines during step **230** of the sequence **224** if either the right side alarm weight or the right side zero weight values ascertained in step **227** of sequence **224** represent a change from the values ascertained during the 100 ms cycle immediately previous to the present 100 ms cycle. If change is indicated in step **230** of serial communications sequence **224**, the newly ascertained right side values are read from the RAM from the solid state relay board micro-controller **220** and written to the RAM of the left side micro-controller unit **156** in step **231** during the time remaining in the third 25 ms interrupt stage. If no change is indicated in step **230**, serial communications sequence **224** continues in step **232** with a determination of the left side rail micro-controller unit **156** active/inactive status. If in step **232** of serial communication sequence **224**, the left side

micro-controller unit **156** is found to be active for scale functions the remaining time in the third 25 ms interrupt stage is utilized in step **233** to read raw weight data from the RAM of the solid state relay board micro-controller unit **220** and write the retrieved data to the RAM of the left side micro-controller unit **156**. If in step **232** of serial communication sequence **224** the left side micro-controller unit **156** is found to be inactive for scale functions, the remaining time in third 25 ms interrupt stage is utilized in step **234** of sequence **224** to read raw weight data from the RAM of the scale interface unit **222** and write the retrieved data to the RAM of the solid state relay board **220**.

The fourth 25 ms interrupt stage of serial communications sequence **224** commences in step **235** with the determination of whether the left side rail micro-controller unit **156** has been activated for scale functions within the present 100 ms cycle. If in step **235** of serial communication sequence of **224** it is determined that the left side rail micro-controller unit **156** has been activated for scale functions within the present cycle, the time remaining in the fourth 25 ms interrupt stage is utilized in step **236** to replace display of scale information on the right side rail LCD **216** by a message stating that the right side is inactive for scale functions. If in step **235** it is determined that the left side rail micro-controller unit **156** has not been recently activated for scale functions, communications sequence **224** continues in step **237** with determination of whether either the left side alarm weight or left side zero weight values ascertained in step **226** of sequence **224** represents change from the values ascertained during the 100 ms cycle immediately previous to the present 100 ms cycle.

If change is indicated in step **237** of serial communications sequence **224**, the newly ascertained left side values are read from the RAM of the solid state relay board **220** and written to the RAM of the right side micro-controller unit **215** in step **238** during the time remaining in the fourth 25 ms interrupt stage. If no change is indicated in step **237**, serial communications sequence **224** continues in step **239** with determination of whether the right side rail micro-controller unit **215** is active or

inactive for scale functions. If during step **239** of serial communications sequence **224** it is determined the right side micro-controller unit **215** is active for scale functions the sequence **224** continues in step **156** by utilizing the remaining time of the fourth 25 ms interrupt stage to read raw weight data from the RAM of the solid state relay board micro-controller unit **220** and write the retrieved data to the RAM of right side micro-controller unit **215**. If in step of **239** of sequence **224** it is determined that the right side micro-controller unit **215** is not active for scale functions, the time remaining in the fourth 25 ms interrupt stage is utilized in step **241** of sequence **224** to read raw weight data from the RAM of the scale interface unit **220** and write the retrieved data to the RAM of the solid state relay board micro-controller unit **220**. The sequence then repeats **242** commencing at step **225**.

It is also notable that the foregoing description primarily describes an embodiment that is substantially the same as a product which is commercially available under the designation "BariKare" Bed. This bed, which is in essence bed **29,** has an overall length of 87.5 inches, a height variable between 21.25 to 27.5" from the floor to the hard pan surface of the seat section, a mattress 11 measuring 80"L by 36"W by 5" thick, a caster diameter of 5", siderail height of 21.5", siderail length of 48", and overall bed weight of roughly 665 pounds. The width of such bed varies depending on which position the siderails are in -- 40.25" with the siderails in the transport position, 43.25" with the siderails in the normal position, and 54" with the siderails in the extended position. The same dimensions are applicable to the above-described bed 29. As of filing of this application, such "BariKare" Bed is available through Kinetic Concepts, Inc. of San Antonio, Texas. Accordingly, reference to such commercially available bed and/or its accompanying descriptive information may provide even further understanding of the finer points of the preferred embodiments.

Although the present inventions have been described in terms of the forgoing embodiments, this description has been provided by way of example only and is not to be construed as a limitation

on the invention, the scope of which is only limited by the following claims. Those skilled in the art will recognize that many variations, alternations, modifications, substitutions and the like are ready possible to the above-described embodiments. Only a partial sampling of such variations have been pointed out herein.